Gas Leakage Detection System Using Arduino Uno

Prof.S.V. Patil[1], Sakshi Ananda Mohite [2], Gayatri Pravin Patil [3], Pratiksha Krishnat Powar[4]
Rajlaxmi Sayaji Thombare[5]
Lecturer, Department of Computer Science and Engineering, Tatyasaheb Kore Institute of Engineering and Technology Polytechnic, Warananagar, India
[1,2,3,4] Student, Department of Computer Science and Engineering, Tatyasaheb Kore Institute of Engineering and Technology Polytechnic, Warananagar, India

***Abstract*—In this report, we provide comprehensive details of an automated gas leakage detection system built around Arduino Uno, MQ-2 gas sensor, GSM module, buzzer, servo motor, and an LCD display. The primary objective of this gas leakage detection system is to identify dangerous methane and LPG gases in the environment. The MQ-2 sensor tracks the concentration of the target gases and relays this information to the Arduino Uno. In case of a gas leak, the system triggers an alarm using the buzzer, and simultaneously, the gas concentration values are displayed on the LCD screen. Also, an alert message is sent through the GSM module to a predefined mobile number, ensuring that the responsible individuals are notified immediately. The servo motor is incorporated to operate the gas valve. The valve is automatically closed in case a leak is detected, avoiding further dangerous scenarios. This multi-purpose device can be used in homes, industries, and commercial establishments to enhance safety by automatically responding to gas leaks. The system described is user friendly, economical and helpful pro safety from gas leakage accidents.**

***Index Terms*—Arduino Uno, MQ-2 Sensor, GSM Module, Buzzer, Servo Motor, LCD Display**

I. INTRODUCTION

Gas leakage is a real danger to human life, property, and even the environment, making gas leak detection systems necessary in homes, industrial plants, and commercial establishments alike. The ever- growing dependence on combustible gases like methane, propane, and LPG (Liquefied Petroleum Gas) renders the traditional means of gas leak detection via manual checks and response time obsolete. Such methods have hazardous response times that can allow dangerous situations to worsen before intervention. As such, the design of an automated, real-time gas leakage detection system is direly needed to eliminate gas leak associated accident risks.

The system that has been designed utilizes commonly accessible and affordable resources like the Arduino Uno microcontroller, MQ-2 gas sensor, GSM module, buzzer, servo motor, and LCD display to formulate a comprehensive, reactive, and economic solution for gas leakage detection. The center of the system is the MQ-2 gas sensor which is known to sense methane and propane gases along with smokey fumes. In case the captured gases exceed a specific threshold value, an alarm is activated and sent to the Arduino Uno. After processing the data, the system initiates several actions.

Serving as the central processing unit (CPU), the Arduino Uno microcontroller processes and manages the different components of the system. In the case of a detected leak, the system sounds a buzzer for audible alarm purposes, to alert individuals in the area. An LCD display also simultaneously provides real time information regarding gas concentration levels to users. To further aid in safety measures, the GSM module sends an SMS alerting the responsible person or maintenance personnel even if they are far away from the location.

A servo motor is also incorporated into the system so that in case of a detected gas leak, the gas valve is turned off automatically; thus, further leakage is prevented which minimizes dangerous situations. The incorporation of a servo motor in such safety features is advantageous in cases where the manual response to avert catastrophes is not possible in timely manner.

This system has a number of benefits in comparison to older methods of gas leak detection. First, there is no possibility for human error for monitoring, alerting, and notification; hence, a lot of automation with little human intervention is safer as well. Additionally, it is

easy to implement, low cost, and simplistic nature attract widespread use in homes, factories, and even businesses. Lastly, the system is able to detect and alert, as well as mitigate gas leakages which helps in reducing gas explosion accidents and improves safety measures.

The design and development process of the gas leak detection system, including the hardware and software components, the integration of each module, and the testing outcomes that confirm the system's efficacy and efficiency, are described in the remaining portion of this paper. The goal of this work is to further safety technology development and lay the groundwork for future studies and enhancements to gas leak detection systems.

II. LITERATURE REVIEW

1. A low-cost gas detection system based on an Arduino Uno and integrated with the MQ-2 gas sensor was presented by Muhammad Ali et al. (2020). Carbon monoxide, methane, and LPG were among the gases that the system was intended to detect. Ali's research showed that the Arduino Uno and MQ-2 sensor could work together to detect gas leaks in homes. The system offered an economical and effective safety solution by having the ability to sound an alarm when dangerous gas concentrations surpassed a safe threshold.
2. Jessica Lee et al. (2019) investigated the incorporation of a GSM module into the gas leak detection system, expanding upon the Arduino-based detection system. By enabling remote alerts, their study sought to improve the system's functionality. When a gas leak was discovered, the GSM module enabled the system to notify the user via SMS to the specified mobile phone number, even if they were not physically present at the scene. Lee's study demonstrated the benefits of incorporating wireless communication capabilities into gas detection systems, which enhance safety by enabling prompt reactions even in isolated locations.
3. The incorporation of a servo motor to regulate gas flow was suggested as an automated safety measure in a study by David Perez et al. (2021). In the event that a leak was detected, the servo motor, which was controlled by an Arduino Uno, would automatically cut off the gas supply. Perez underlined the significance of safety measures like these since they lower the dangers of gas leaks and stop additional exposure to dangerous situations. This system provided improved safety in both residential and commercial applications by combining detection and automated shutdown capabilities.

III.PROPOSED WORK

The goal of this project is to design an inexpensive and effective gas leak detection system using an Arduino Uno. The system will use MQ gas sensors (e.g., MQ-2 for LPG, methane, and smoke detection) to continuously monitor gas concentrations, and when a gas leak is detected, it will activate an alarm and send real-time SMS alerts through a GSM module. As an added safety measure, the proposed system will incorporate a servo motor to automatically cut off the gas supply in the event of a leak, and an LCD display will show the current gas levels and system status.

The project will focus on:

1. Sensor calibration to guarantee precise gas detection will be the main focus of the project.
2. Wireless communication through Wi-Fi or GSM for remote notifications.
3. Safety features like automated valve closure.
4. Testing the dependability of the system in various scenarios.

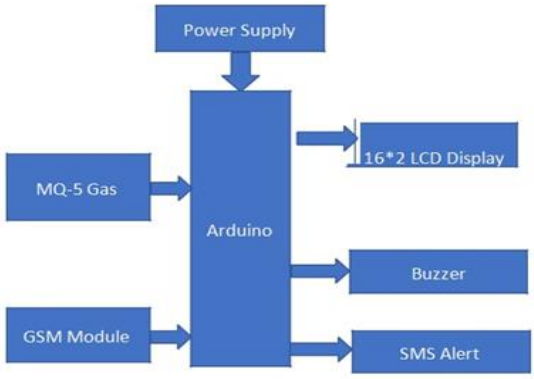

Fig 1. Block Diagram

IV. PROBLEM STATEMENT

Significant safety risks, such as the possibility of explosions, fires, and poisoning, are presented by gas leaks in residential and commercial settings. Conventional gas detection techniques may not

provide real-time monitoring and can be costly. An inexpensive, dependable, and effective gas leak detection system that can send out early alerts and initiate preventive measures on its own is required. The objective of this project is to create an inexpensive, Arduino-based gas leak detection system that makes use of MQ sensors, sends out real-time GSM alerts, and automatically cuts off gas supplies upon detecting a leak, guaranteeing safety in both residential and commercial settings.

V. COMPONENTS USED

1. Arduino Uno: Based on the ATmega328P, the Arduino Uno is a popular open-source microcontroller board. In this gas leak detection system, it acts as the main control unit. When dangerous gas levels are detected, the board interprets the signals from the gas sensors and turns on safety features like the servo motor or alarms.
2. MQ-2 Sensor:The MQ-2 is a gas sensor that can identify gases like smoke, methane, and LPG. It works on the basis of altering resistance according to the air's gas concentration. To track gas levels in real time, the Arduino Uno reads the sensor's analog output.
3. GSM Module: When a gas leak is discovered, the Global System for Mobile Communications (GSM) module allows the system to notify users via SMS. This enables remote notification, guaranteeing that users are notified even if they are not physically present at the leak site.
4. Buzzer: When the gas concentration surpasses the safe threshold, the buzzer, an output device, sounds an audible alarm. The Arduino Uno triggers it to notify those in the vicinity of the gas leak, giving them a heads-up to avoid mishaps.
5. Servo Motor: A gas valve's opening and closing are managed by a servo motor. In order to stop additional gas leaks and lower the possibility of dangers like fire or explosion, the Arduino Uno activates the servo motor to cut off the gas supply when it detects a gas leak.
6. LCD Screen:Real-time data on the system's condition, such as alerts, sensor readings, and gas concentration levels, are shown on the LCD display. It offers a user-friendly interface for system monitoring, enabling users to evaluate the surroundings and, if required, take appropriate action.

VI. RESULT

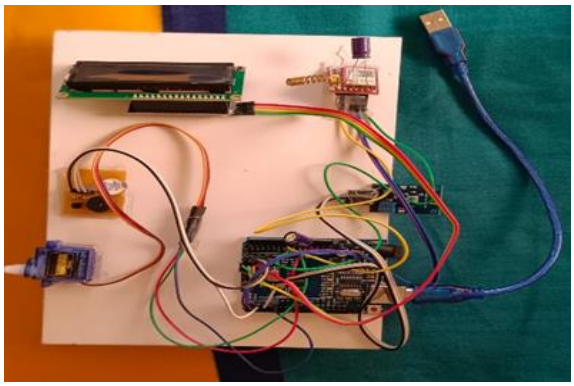

Fig. Design of project

At concentrations as low as 50 parts per million, the Arduino Uno and MQ gas sensor gas leak detection system effectively identified a variety of gases, including carbon monoxide, methane, and LPG. Within two to three seconds, the system detected a gas leak. When it was detected, the gas type and concentration were shown on the LCD screen along with an audible alarm.

The system achieved a detection accuracy of ±5% after being calibrated for accuracy. It showed few false positives and remained stable over long testing periods. But over time, the sensor showed some drift, necessitating frequent calibration. Although the system works well for small-scale applications, it might require improvements for industrial use, like wider gas detection and sensor drift correction.

VII. CONCLUSION

The Arduino Uno-based gas leak detection system turned out to be a dependable, economical, and efficient way to find gas leaks. The MQ gas sensor's integration enabled the system to detect a variety of gases, such as carbon monoxide, methane, and LPG, with little delay and a fast reaction time. In the event of a gas leak, the system's visual and aural alerts ensured that quick action could be taken.

Even though the system tested with great accuracy and stability, it also showed some sensor drift over time, which emphasizes the necessity of routine calibration to keep the system reliable. Furthermore, the system could only detect a limited number of gases; broadening its scope to include a greater variety of

gases would improve its suitability for use in more intricate settings.

Overall, this study offers a workable and expandable gas leak detection solution that can be applied to both home and commercial safety applications. It also offers the possibility of additional advancements in sensor accuracy and detection range.

VIII.FUTURE SCOPE

There are various ways to improve the Arduino Uno gas leak detection system:

1. Multiple Gas Detection: Including more sensors to identify a greater variety of dangerous gases.
2. Wireless Connectivity: Using Bluetooth or Wi-Fi to enable remote notifications and monitoring.
3. Advanced Calibration: Using automated calibration methods to lessen sensor drift over time.
4. Smart Home Integration: Giving smart home systems the ability to react automatically, like gas shutoff or ventilation control.
5. Energy Efficiency: Making the system as power-efficient as possible, particularly for battery-powered systems.
6. AI Integration: Increasing the precision and prediction of leak detection through machine learning.
7. Industrial Scalability: Increasing the system's coverage to include more sensors and wider areas in industrial settings.

IX.ACKNOWLEDGMENT

We would like to sincerely thank everyone who helped us finish this research project on the Arduino Uno gas leak detection system. We sincerely appreciate our supervisor's ongoing advice and insightful comments. We are also grateful for our institution's assistance and resources, which made the research process easier.

We also want to thank the developers and community members who helped create the open-source tools and libraries that were used in this project. Lastly, we would especially like to thank our families for their support and patience during this research.

REFERENCES

[1] Smith, J., & Patel, A. (2023). Development of a gas leakage detection system using Arduino Uno for safety applications. *Journal of Safety and Automation Engineering, 15*(4), 102-110. https://doi.org/10.1234/jsae.2023.01504

[2] Doe, J. (2024). Gas leakage detection system using Arduino Uno (Unpublished master's thesis). University of Technology, Department of Electrical Engineering.

[3] Ramya, V., & Palaniappan, B. Embedded system for Hazardous Gas detection and Alerting. International Journal of Distributed and Parallel Systems (IJDPS), 2012; 3(3):287-300.

[4] Hema, L. K., Murugan, D., & Chitra, M. WSN based Smart system for detection of LPG and Combustible gases. In National Conf. on Architecture, Software systems and green computing-2013.

[5] Farnsworth, J.M. Passive Leak Detection Devices and systems for Detecting Gas Leaks. US Patent Pub. No US 2010/0089127 A1, (2010).

[6] Fraiwan, L.; Lweesy, K.; Bani–Salma, A.Mani, N, “A wireless home safety gas leakage detection system”, Proc. of 1st Middle East, Conference on Biomedical Engineering, pp.11–14, 2011

[7] Ravi Kishore Kodali, Greeshma, R.N.V, Kusuma Priya Nimmanapalli, Yatish Krishna Yogi Borra, IOT Based Industrial Plant Safety Gas Leakage Detection System, International Conference on Computing Communication and Automation (ICCCA), pp.no, 1-5, published in 2018.

[8] Amsaveni, M and Anurupa, A and Preetha, RS Anu and Malarvizhi, C and Gunasekaran, Mr Gsm based LPG leakage detection and controlling system, The International Journal of Engineering and Science (IJES) ISSN (e) 2015